

EFFECT OF SHADE DEPTH (%) AND RING FRAME PROCESS PARAMETERS ON COTTON-VISCOSE BLENDED MÉLANGE YARN QUALITY

SUCHIBRATA RAY

PHD Government College of Engineering and Textile Technology, Serampore, Hooghly, West Bengal

ABSTRACT

Demand for mélangé yarns is increasing day by day because of its special colour appearance and environmental friendly spinning technology associated with it. In the present work, an investigation has been made to study the effect of important spinning process variables namely shade depth, ring frame spindle speed and yarn twist multiplier (TM) on various yarn quality parameters like unevenness, strength, imperfection, Breaking extension, yarn CSP, hairiness index and yarn specific volume of Ne 30s cotton/viscose blended mélangé yarn. It has been found that yarn qualities like tenacity, breaking extension (%) deteriorates and hairiness index, imperfections increases for higher shade depth (%) and production speed. Yarn specific volume increases with the increase in shade depth (%) of yarn and with the increase in ring frame spindle speed specific volume decreases. Deterioration in mélangé yarn quality with the increase in black viscose fibre content in the yarn can be explained by the deterioration of fibre strength after dyeing and generation of weak and short fibres when the dyed fibres are processed in blow room and card.

KEYWORDS: Blow Room, Cotton, Viscose, Mélangé yarn, Shade Depth, Yarn Quality & TM

Received: Oct 06, 2021; **Accepted:** Oct 26, 2021; **Published:** Nov 15, 2021; **Paper Id:** IJTFTDEC20217

INTRODUCTION

In the modern era of textile, production and modification of fancy yarns have become a tradition. Fancy yarns are nothing but yarns with deliberate irregular characteristics present within their morphology. There are numerous fancy yarns available in the market. For example, marl yarn, spiral yarn, gimp yarn, slub yarn, diamond yarn, loop yarn, snarl yarn, knop yarn, mélangé yarn are various types of fancy yarns. Mélangé yarns are a type of fancy yarns which consist of different coloured fibres within their cross-section to give a unique optical appearance and aesthetic appeal in the fabric. Mixing of different coloured fibres can be done either in the blow room stage (tuft blending) or in draw frame stage (sliver blending). Production of mélangé yarn is so much popular not only because of its special colour appearance but also the eco-friendly spinning technology associated with it.

According to Ray S et al. (2018) quality of mélangé yarn is improved when draw frame blending methodology is used rather than blow room blending methodology. With the increase in dyed fibre percentage, commonly known as shade depth (%), the yarn quality like strength and breaking elongation deteriorates and unevenness, imperfection and hairiness increases. Karim et al. (2007) believed that the quality of mélangé yarn experiences a significant reduction in strength as dyed fibres become damaged to a tune of the higher index during bleaching and dyeing. Deterioration of yarn properties are observed for both ring- and rotor-spun yarn but the extent of deterioration is significantly higher for rotor spun yarn than ring-spun yarn. Though the draw frame blending methodology improves yarn quality but it was accompanied by an increase in hairiness. Moghassem A (2007) found that the number of neps per unit weight is more for dyed cotton fibre than grey cotton fibre. Cotton

fibre dyeing process leads to an increase in short fibre content. They have also found that the extent of fibre damage is less in blow room as compared to carding machine. Ray S et al. (2018) pointed out that yarn unevenness has not been significantly influenced by TM but it is affected by spindle speed and shade depth (%) non-linearly. After dyeing process, not only surface properties of the fibres change, but also entanglement and fibre to fibre friction increases. Dyed fibres became coarser after dyeing and that leads to an increase in the hairiness index of the yarn. Ray S et al. (2018) mentioned that yarn strength is affected most by shade depth (%) followed by TM and spindle speed whereas for breaking extension the most dominating factor is spindle speed followed by TM and shade depth (%). On the other hand, shade depth (%) influences the U%, IPI and HI the most followed by spindle speed. Regar M et al. (2017) made a comparison between ring- and compact-spun yarns and stated that yarn properties like RKM, breaking elongation improve when shade depth (%) and spacer size reduces and these properties also improve when conventional spinning process is replaced by compact spinning. Effect of dyed fibre (%) on yarn properties is also found lesser for compact spun yarn than conventional one. Zou Z (2014) studied on viscose vortex colored spun yarn and found that yarn tenacity increases initially with the increase in nozzle pressure but further increase in nozzle pressure decreases tenacity of yarn whereas the yarn tenacity and elongation at break decreases with the increase in yarn delivery speed. Yarn hairiness increases with the increase in yarn delivery speed. Naik H et al. (2008) stated that increase in shade depth (%) of mélange yarn restricts the melange effect and that also causes difficulty in fine count mélange yarn production. Behera B et al. (1997) suggested that processing of grey and dyed fibres separately in blow room and card improves yarn quality from imperfection and unevenness of yarn point of view. Blow room blending improves the shade uniformity of yarn samples compared to draw frame blending. Ishtiaque S M (1986) studied the effect of yarn twist and count on the yarn packing density for both ring- and rotor-spun yarn. They concluded that the packing density for rotor-spun yarn is less than that of the ring-spun yarn and packing density found less for coarser yarn than the finer one for the same material and twist coefficient.

There is hardly any work reported on the effect of raw material and important ring frame process parameters on cotton/viscose blended mélange yarn qualities. This study is therefore undertaken to investigate the effect of process parameters at different shade depth (%) on the properties of cotton/viscose blended mélange yarn.

MATERIALS AND METHODS

Materials

Mech-1 grey cotton fibres and black dope dyed viscose fibres were used to produce 30s Ne blow room blended mélange yarn. Cotton and dyed viscose fiber properties are given in Table 1.

Table 1: Fibre Properties

Fiber	2.5% Span Length (mm)	Fineness (Micronaire)	Breaking Strength (cN/tex)
Grey (raw cotton)	28.5	4	29
Coloured (dyed viscose)	38	4.31	1.5 g/d

The dyed viscose fibers were opened in Mixing Bale Opener (MBO) and the same is blended with un-dyed cotton fibers by weight following stack blending process. The percentage of dyed viscose fiber in the mixing is commonly termed as shade percentage or shade depth (%). The blended fibres (dyed viscose and grey cotton) were then processed through Lakshmi blow room line, chute feed carding (LC 300), breaker draw frame (RSB 851), finisher draw frame (RSB 851) and

speed frame (LF 1400 A) before spinning in conventional ring frame (LR6). Total 18 yarn samples were prepared using three different spindle speeds, three different dyed viscose fibres (%) and two different yarn TM level. The details of sample preparation plan are shown in **Table 2**.

Table 2: Yarn Sample Preparation Plan

Sample No.	TM (TPI/Ne ^{0.5})	Shade Depth (%)	Spindle Speed (rpm)
1	3.8	1	16500
2	3.8	1	17500
3	3.8	1	18500
4	3.8	5	16500
5	3.8	5	17500
6	3.8	5	18500
7	3.8	15	16500
8	3.8	15	17500
9	3.8	15	18500
10	3.9	1	16500
11	3.9	1	17500
12	3.9	1	18500
13	3.9	5	16500
14	3.9	5	17500
15	3.9	5	18500
16	3.9	15	16500
17	3.9	15	17500
18	3.9	15	18500

Testing

All the eighteen (18) yarn samples were kept under standard atmospheric condition of $27 \pm 2^\circ\text{C}$ and relative humidity (RH) of $65 \pm 4\%$ for 24 hours. Thereafter the yarn samples were tested for yarn unevenness (U %), imperfection (IPI), strength and yarn specific volume. Yarn unevenness (U %), imperfection (IPI) were evaluated in capacitance based “Uster Premium Tester 4” (Tensioner type – D and sensor type – B, conveyer, Absorber type – b). In testing, yarn withdrawal speed was maintained at 400 m/min for testing time of 1 min. For each of the 18 yarn samples, 10 readings were taken for measuring average U% and IPI. Single yarn strength and breaking extension (%) of the yarn samples were measured using “INSTRON TENSILE TESTER”(SYSTEM ID NUMBER 3366K2361) where the speed of the upper jaw was fixed at 300 mm/ min, gauge length was set at 500 mm and pre-tension was maintained at 0.5 cN/tex. Yarn diameters were measured using projectina microscope for calculating the specific volume of the yarn samples.

RESULTS AND DISCUSSIONS

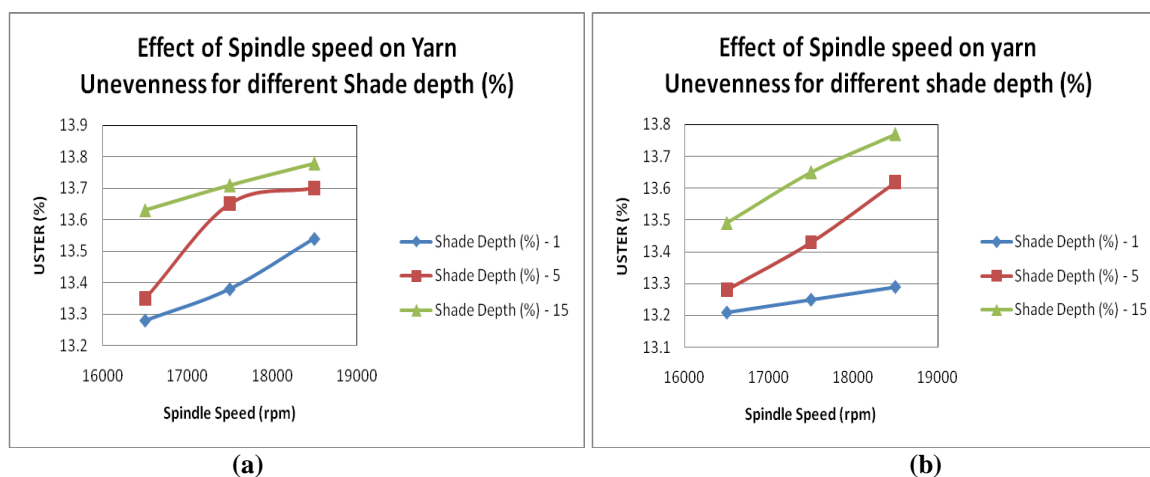
The experimental values of yarn unevenness, strength, imperfections (IPI) and specific volume of 30^s Ne cotton/viscose blended mélange yarns are tabulated in **Table 3**.

Table 3. Results of Cotton/Viscose Blended Mélange Yarn (30's Ne) Properties

Sample No.	Unevenness (U %)	Strength (g/tex)	Imperfection per km (IPI)	Specific volume (cm ³ /g)
1	13.28	13.16	1940	1.57
2	13.38	13.05	1947.5	1.34
3	13.54	12.92	2170	1.27
4	13.35	13.06	1980	2.14
5	13.65	12.51	2047.5	2.12
6	13.70	12.16	2190	2.07
7	13.63	12.99	2025	2.92
8	13.71	12.11	2092.5	2.76
9	13.78	11.80	2230	2.42
10	13.21	13.77	1930	1.45
11	13.25	13.32	1940	1.29
12	13.29	13.02	2095	1.17
13	13.28	13.56	1947.5	1.99
14	13.43	13.12	2036	1.91
15	13.62	12.97	2127.5	1.84
16	13.49	13.16	1951	2.45
17	13.65	12.80	2079	2.35
18	13.77	12.62	2152	2.08

Yarn Unevenness (U %)

The test results of Ne 30s cotton/viscose blended mélange yarn samples are given in **Table 3**. Figure 1(a) and (b) depicts the effect of spindle speed on yarn unevenness for three different shade depth levels corresponding to TM level 3.8 and 3.9 respectively.

**Figure 1: Effect of Spindle Speed on Yarn Unevenness for Different Shade Depth (%) : (a) TM-3.8, (b) TM-3.9**

It is observed from Figure 1 that yarn unevenness increases with the increase of shade depth. Yarn unevenness increases with shade depth for both the TM levels. Any chemical processing affects the fiber surface characteristics. The change in surface characteristics of dyed viscose results in higher fiber to fiber friction. Increased fiber to fiber friction causes difficulties in opening and further processes of yarn manufacturing. It is obvious that the increased share of dyed portion in the mixture further intensify the problem. Opening difficulties lead to uneven movement of fibre cluster in the drafting zone. Uneven movement of fibre cluster in the drafting zone results into cross sectional mass variation which in

turns increase yarn unevenness. From Figure 1 it is also observed that yarn unevenness increase with increased spindle speed, more at higher shade depth %. Higher spindle speed causes more rubbing action of yarn with the metallic part in the ring frame may cause increase in yarn unevenness. Moreover, drafting speed also increases at higher spindle speed and chances of uneven movement of fibres in the drafting zone increase at higher drafting speed.

Yarn Imperfection (IPI)

Test result of cotton viscose blended mélange yarn imperfection is shown in **Table 3**. Figure 2 illustrates the effect of spindle speed and shade depth on yarn imperfection.

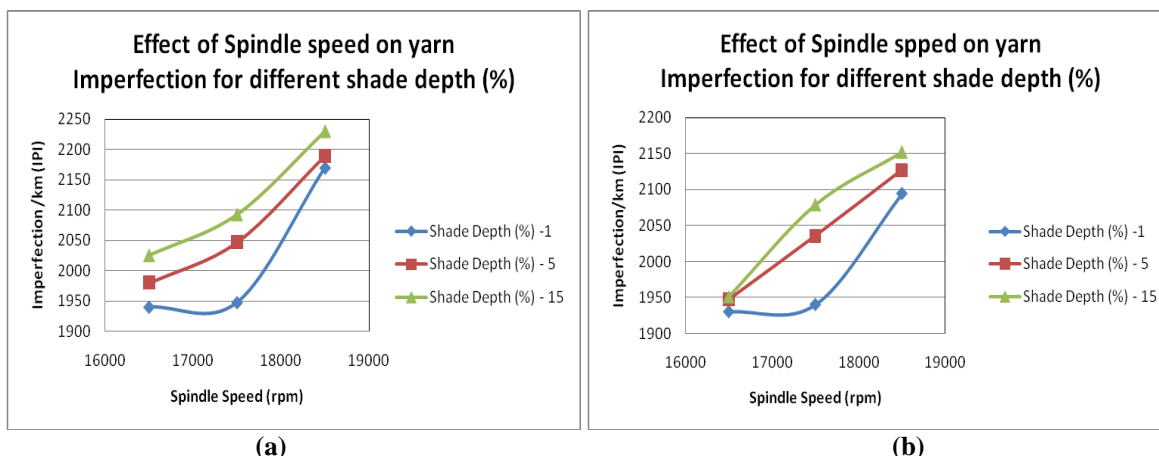


Figure 1: Effect of Spindle Speed on Yarn Imperfection for Different Shade Depth (%) : (a) TM-3.8, (b) TM-3.9

It is observed from Figure 2 that imperfection of cotton /viscose blended mélange yarn increases with the increase of shade depth and spindle speed. The increase is steeper in the case of higher shade depth. Opening and processing difficulties as discussed in the previous paragraph associated with mélange yarn manufacturing causes more dyed fiber damage and the resulting reduction in effective length of fibers. Presences of more number of short fibers lead to drafting wave generation in the drafting zone. In addition to that dyed fiber entanglement results in more fibrous neps.

Higher spindle speed of ring frame leads to higher spinning tension and larger balloon diameter. Therefore, increased spindle speed causes more abrasion between yarn and thread guide, balloon control ring, traveler. Increased rubbing action leads to rolling up of protruding fibres on the yarn body resulting in higher neps and thick places in the yarn.

Yarn Strength (gm/Tex)

Table 3 shows the test results of yarn strength for 30s cotton / viscose blended mélange yarn. Figure 3 (a) and (b) illustrates the effect of spindle speed and shade depth on mélange yarn strength for two different levels of yarn TM 3.8 and 3.9 respectively.

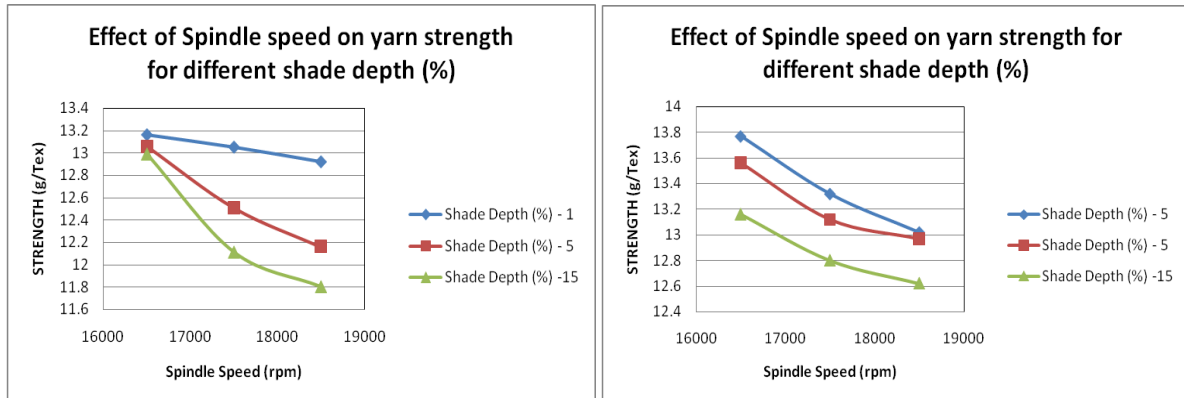


Figure 3: Effect of Spindle Speed on Yarn Strength for Different Shade Depth (%): (a) TM - 3.8, (b) TM-3.9.

It can be observed from Figure 3 that yarn strength reduces with the increase of shade depth (%) and that may be ascribed to the higher proportion of dyed cotton fiber content in the yarn cross section. It has been discussed earlier that chemical processing causes change in surface characteristics of dyed fiber and the kind of mechanical processing involved in yarn manufacturing causes damage to dyed fiber resulting more short fiber generation. Shorter length fiber always contributes less towards the yarn strength. The figure also concludes that the yarn strength increase with increase in twist level (TM). With higher twist level, Fiber-to-fiber cohesion increases by increased surface contact area and thereby resulting into yarn strength.

Yarn Specific Volume (cm^3/gm)

The test results of yarn specific volume are given in **Table 3**. The effects of spindle speed and shade depth on yarn specific volume are shown in Figure 4 (a) and (b) for yarn TM 3.8 and 3.9 respectively.

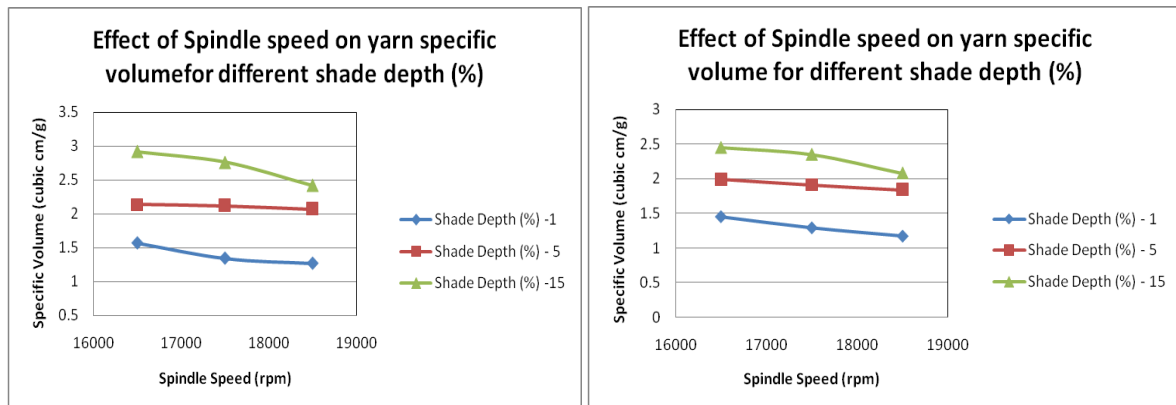


Figure 4: Effect of Spindle Speed on Yarn Specific Volume for Different Shade Depth (%): (a) TM- 3.8, (b) TM - 3.9.

Specific volume of any substrate can be simply defined as the volume per unit mass of the substrate. So it is inversely related with the density of the substrate. From Figure 4 it can be noted that specific volume of yarn increases with the increase of shade depth (%). The dyeing causes the fibre coarser and maybe that makes the fibre stiffer. The presence of more dyed fibre in yarn cross section therefore makes the mélange yarn fluffy. From the figure, it is also observed that there is marginal change in yarn specific volume with spindle speed. The yarn specific volume decreases with the increase in spindle speed. At higher spindle speed yarn is spun at higher level of tension. Higher spinning tension causes shorter

spinning triangle. Shorter spinning triangle leads to decrease in angle of binding of fibres in the yarn body thus fibres come closer to each other resulting reduction in specific volume of yarn.

CONCLUSIONS

In this present work, we have tried to analyze the simultaneous effects of raw material (dyed viscose fiber %), spinning process parameter (yarn TM) and productivity (spindle speed of ring frame) on the cotton / viscose blended mélange yarn. The conclusions are made as under:

- The yarn strength deteriorates with the increase in percentage of dyed viscose fibres in yarn cross-section. The yarn strength also shows a similar trend with the increase of spindle speed at ring frame. Yarn strength found on higher side for higher TM.
- Higher shade depth is responsible for higher yarn unevenness and imperfection. Ring frame spindle speed also affects yarn unevenness and imperfection. Yarn TM has marginal effect on yarn unevenness and imperfection.
- Yarn specific volume increases with increase in shade depth (%) of mélange yarn and the specific volume decreases with the increase of ring frame spindle speed. Specific volume decreases when the yarn TM increases.
- The change in surface characteristics of textile fibers after dyeing make the productivity level a limiting factor in achieving better mélange yarn quality, especially for darker shades.

REFERENCES

1. Behera, B.K., Hari, P.K., Bansal, Seema. and, Singh, Rahul. 1997. *Effect of different blending methods and blending stages on properties of Mélange yarn.* Indian Journal of Fibre & Textile Research 22: 84-88.
2. Ishtiaque, S. M. 1986. *Radial Packing Density of Rotor- and Ring-spun Yarns.* Indian Journal of Fibre & Textile Research 11:208-214.
3. Karim, S., Gharehaghaji, A. and Tavanaie, H. 2007. *A Study of the Damage Caused to dyed Cotton Fibres and its Effect on the Properties of Rotor- and Ring-Spun Melange Yarns.* FIBRES & TEXTILE in Eastern Europe 15, No. 3 (62):63-67.
4. Moghassem, A, R. 2008. *Study on the dyed cotton fibres damage in spinning processes and its effect on the cotton mélange yarn properties.* Research Journal of Textile and Apparel 12(1):71-78.
5. Naik, Hanumant. H.S. and Bhat, P. N.2008. *Production of melange yarns-A review.* Man-made Textiles in India May: 161-165.
6. Ray, S., Ghosh, A. and Banerjee, D. 2018. *Effect of Blending Methodologies on Cotton Mélange Yarn Quality.* FIBRES & TEXTILE in Eastern Europe 26, 5(131) :41-46.
7. Ray, S., Ghosh, A. and Banerjee, D. 2018. *Analyzing the Effect of Spinning Process Variables on Blow room Blended Cotton Mélange Yarn Quality.* Research Journal of Textile and Apparel 22/1:2-14.
8. Ray, S., Ghosh, A. and Banerjee, D. 2018. *Effect of spinning process parameters on mélange yarn quality by Taguchi experimental design.* Indian Journal of Fibre & Textile Research. 43: 295-300.
9. Regar, M.L., Amjad, A. I. and Aikat, N. 2017. *Studies on the properties of ring and compact*
10. *spun melange yarn.* International Journal of Advance Research and Innovative Ideas in Education 3 (2): 476-483

11. Zou, Z. 2014. *Effect of process variables on properties of viscose vortex coloured spun yarn*. *Indian Journal of Fibre & Textile Research* 39:296-302.
12. Bakieva, A. N. A. R., et al. "Developing new type of disk plate for meat chopper and its effect to water-binding capacity and yield stress of minced meat." *International Journal of Mechanical and Production Engineering Research and Development* 9.6 (2019): 377-390.
13. Shaik, Bazani, G. Harinath Gowd, and B. Durga Prasad. "An Optimization and Investigation Of Mechanical Properties and Microstructures On Friction Stir Welding Of Aluminium Alloys." *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)*, ISSN (P): 2249-6890.
14. Kumar, Ranjith, and Faouzi Sakli. "Quality of New Kind of Yarns versus Ring Spun Yarns—Comparative Study."
15. Nikam, Harshal, P. R. E. M. Mishra, and Sayali Bharambe. "Design and Analysis of Brake Rotor with Parameter Optimization." *International Journal of Automobile Engineering Research and Development (IJAuERD)* 4.4 (2014): 21-30.